SLASH PINE IMPROVED PLANTING STOCK- VEGETATION CONTROL STUDY- AGE 15 RESULTS

Plantation Management Research Cooperative

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EXECUTIVE SUMMARY

A designed experimental study was established at 19 locations in the Coastal Plain region of Georgia and northern Florida with the objective of evaluating the impacts of first generation genetic improvement, and of combining genetic improvement and vegetation control on yields of slash pine. A mixed model approach was used to analyze the age 15 measurements for this study and the 3-yr periodic growth from ages 12 to 15 yr. Installation and all installation interactions were treated as random factors and competition control and genetics were treated as fixed factors. The two levels of competition control were either none other than that provided by the operational site preparation or complete control. Genetic improvement was either unimproved, bulk lot first generation improved stock or single family.

Competition control significantly increased average tree characteristics and basal area per acre for slash pine. Improved genetics had no significant effect on average dbh or basal area per acre. Average dominant height, total and merchantable volume were significantly increased by both improved genetics and competition control, and the effects are additive in nature. Neither competition control nor genetics significantly affected trees per acre. Improved genetics significantly reduced the percent fusiform infection while competition control significantly increased the infection rate.

The results of the 3-year periodic growth analysis between the ages of 12 and 15 showed that there were no significant differences in dbh growth due to the competition control treatments. This indicates that the early gains due to competition control are being maintained through age 15 for slash pines. Improved genetics significantly affected dbh growth between ages 12 and 15. There was no significant difference between bulk lot and unimproved, but single family was growing significantly slower than unimproved genetic stock. In terms of mean dominant height, there was a significant interaction between improved genetic stock and competition control between the ages of 12 and 15. Basal area per acre growth was not significantly affected by either improved genetics or competition control during the 12 to 15 year growth period. For total volume per acre, competition control continues to significantly increase growth.

The results of this study show that there is a clear benefit from using intensive competition control and improved genetics. Complete competition control has increased total volume by almost 700 ft^3/acre over no competition control. Improved genetic stock has increased total volume an average of 10%. For the age 15 analyses, the gains in total and merchantable volume due to genetics and competition control were determined to be additive in nature which indicates managers can expect to receive the full benefit of both improved genetics and competition control if they use both treatments.

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1 INTRODUCTON

PMRC studies have shown that control of competing vegetation can increase productivity in pine plantations by as much as 100 percent (Pienaar and Rheney, 1995). Another widely used regeneration practice is planting genetically improved seedlings. Results from slash pine first generation progeny tests indicate that volume gains from 7% to 19% (Talbert et al. 1985) are possible. Progeny tests, however, were typically planted as single row plots and often received better cultural treatments, such as mowing and fertilization, than operational plantations. It is likely that these cultural treatments could confound and possibly exaggerate results from progeny tests. Data from these row plots are not useful for developing growth and yield systems that provide breakdowns of stand structure in addition to total yield. Consequently, it is difficult for forest planners to estimate potential gains from using these genetically improved seedlings.

The PMRC designed and installed a study in 1986-87 with the following objectives:

(1) to compare the stand structure and yields of improved and unimproved plantations, with and without competing vegetation,
(2) to examine any interaction effects of genetic improvement and competition control,
(3) to evaluate single family genetically improved plantations versus bulk lot genetically improved plantations, and
(4) to identify and model different mortality patterns, rust infection levels, and yields of improved and unimproved plantations, with and with vegetation control.

This paper summarizes the results of the age 15 measurement analysis of slash pine for this study. Also included are the results of the analysis of the 3-year periodic growth between ages 6 to 9, 9 to 12, and 12 to 15 years.

2 STUDY DESIGN

A designed experimental study was established at 19 locations in the Coastal Plain region of Georgia and northern Florida. Two of these locations were planted during the 1986 planting season and 17 locations were planted in 1987. Genetically improved seed were obtained by polling the PMRC membership to determine the top ten families preferred by each company. The six top-ranked families were tentatively scheduled for inclusion in the study. The families were then checked by personnel at the University of Florida Tree Improvement Program. They compared the family rankings with those provided by the PMRC cooperators and paid particular attention to disease resistance. Once the families were approved, seeds were obtained from rogued first generation open-pollinated seed orchards owned by PMRC cooperators. North Carolina State cooperative identification numbers identify the families chosen for the study in Table 1.

Table 1. Family identification numbers for the slash pine Improved Planting Stock Vegetation Control Study.

Coastal Plain Slash
106-56
6-56
35-60
56-56
261-56
187-57

Unimproved seed was obtained from International Forest Seed Company. This unimproved seed was obtained in the same region encompassed by the study and from areas other than seed orchards or seed production areas. The unimproved seed lot was independent of any check lots used by tree improvement cooperatives.

Bulk lot improved stock was obtained by mixing equal amounts of seed from the six selected families for a particular region. This may actually be better than a bulk lot of all seed in a seed orchard. The seedlings were grown at the Union Camp Corporation nursery at Belleville, Ga. Some seed from each family was kept separate and grown in separate nursery beds for the single family plantings.

Eight 0.4 ac treatment plots were included at each study installation:

(1) Unimproved stock, no vegetation control (UNC),
(2) Unimproved stock, complete vegetation control (UCC),
(3) Bulk lot improved stock, no vegetation control (BNC),
(4) Bulk lot improved stock, complete vegetation control (BCC),
(5) Replicate plot of one of the first four treatments,
(6) Single family improved stock, no vegetation control (SNC),
(7) Single family improved stock, complete control (SCC), and
(8) Replicate plot of one of the single family treatments.

Plots were randomly assigned to each of the six 2x3 factorial treatment combinations. In addition, one of treatments 1-4(#5) and one of treatments 6-7(#8) were randomly assigned to the remaining two plots at each installation. Only one single family was assigned to an installation and the assignments were made at random. Therefore, each family was planted on two to three installations on average. Most locations had some mechanical site preparation as the operational treatment. In the Lower Coastal Plain, the operational site preparation treatment usually included bedding, while in the Upper Coastal Plain site preparation treatments ranged from chop and burn to shear, rake and disc. Each plot was 0.4 acre in size with a centrally located 0.2 acre measurement plot. The two levels of vegetation control were either none, other than that provided by the operational site preparation treatment applied by the cooperator prior to planting, or complete control of all competing vegetation. No herbaceous weed control was applied on the no vegetation control plots. Complete control was achieved and maintained by killing woody vegetation prior to planting with prescribed herbicides, by spraying sulfometuron methyl in early spring of each of the first three growing seasons, and by directed sprays of glyphosate and triclopyr as needed during the growing season.

Seedlings were hand-lifted and planted at a density of 700-750 trees per acre. After the third growing season, every third pine tree on the measurement plot was measured for total height (ft). After the sixth, ninth, twelfth and fifteenth growing seasons, each tree was measured for dbh to the nearest 0.1 inch and checked for stem cankers caused by fusiform rust (*Cronartium quercum* f. sp. *fusiforme*). After the fifteenth growing season all trees were assigned a quality code. The quality codes were defect free, forked, crook or sweep, canker, or broken top. Tagged trees on each plot were measured for height to the nearest foot. The tree height data were used to develop height-diameter regression equations for each plot to estimate the heights of the unmeasured trees. The following height-diameter relationship was fit to each plot at each measurement age:

$$LH = b_0 + b_1 D^{-1}$$

where LH=natural log of height (ft), D=dbh (0.1 in.), and b_0 and b_1= parameter estimates from sample data.

Total (outside bark) and merchantable tree volumes (4-in. min. diameter and 3-in. top ob) were estimated using total and merchantable volume equations developed by Pienaar *et al*. (1987).

3 AGE 15 ANALYSIS AND RESULTS

Installations and all installation interactions were treated as random factors of the experiment, since region-wide recommendations were the objectives of the study. The replication within an installation represented an attempt to quantify the within-location error. We used a mixed model approach for the analysis because it allows for the mixed effects and unbalanced nature of this design. Competition control and genetics were treated as fixed factors. Genetic improvement levels were either unimproved, bulk lot or single family. Analyses were completed separately on the following dependent variables: average dbh, average dominant height, surviving trees per acre, basal area per acre, total and merchantable stem volume per acre, percent fusiform rust infection, percentage of trees defect free, sweep percent, and percentage of forked trees. Effects of genetic improvement were calculated by averaging across both vegetation control treatments, and effects of vegetation control were determined by averaging across both unimproved and improved genetic treatments. Tukey's studentized range test was used to conduct pairwise comparisons of least square means to detect differences between individual treatment level means. All statistical tests were conducted at the overall significance level (experimentwise error rate) of $\alpha=0.05$. To obtain the correct degrees of freedom for this analysis the Satterthwaite option in SAS®'s PROC MIXED (Littell et al. 1996) procedure was used. Unlike traditional analyses, the degrees of freedom may vary between dependent variables. In the discussion of the results, gains due to differences were calculated as differences in least squares means. Least square means are the estimated marginal means over a balanced population, allowing for the unbalanced nature of the experiment.

3.1 Average DBH

Table 2 gives the results of the tests of fixed effects for average dbh for slash pine. Competition control significantly increased average dbh by an average of 0.76 inches across all levels of genetic stock at age 15. There were no significant effects of genetics on average dbh. Table 3 and Figure 1 summarize the least square means for average dbh by treatment.

Table 2. Test of fixed effects for average dbh (inches) for slash pine at age 15.

Source	Numerator Degrees of Freedom	Denominator Degrees of Freedom	Type III F	Pr > F
Genetics	2	101	0.09	0.9178
Competition Control	1	16.1	71.11	<.0001
Genetics* Competition Control	2	99.6	0.21	0.8093

Table 3. Summary of least squares means for average dbh (inches) for slash pine at age 15.

	No Control	Complete Control	Average
Unimproved	5.09	5.86	5.48
Bulk Lot	5.13	5.83	5.48
Single Family	5.11	5.90	5.51
Average	5.11	5.87	5.49

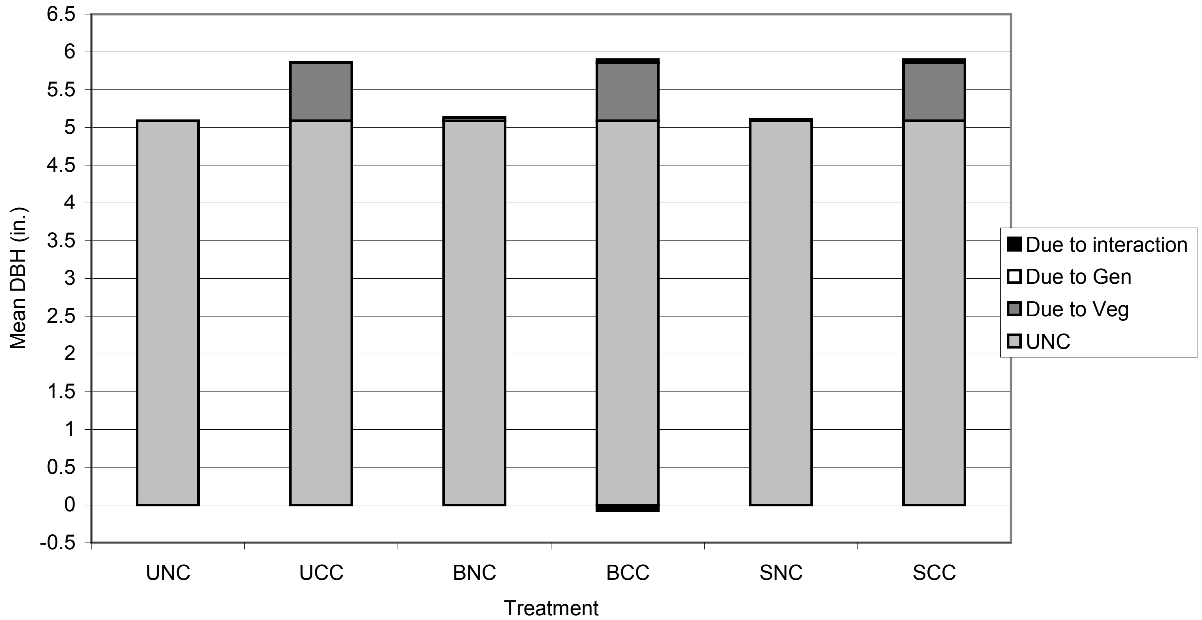

Figure 1. Effects of genetics and competition control on mean dbh by treatment for 15-yr-old slash pine.

3.2 Average Dominant Height

Table 4 gives the results of the tests of fixed effects for average dominant height. Competition control significantly increased average dominant height by an average of 4.2 feet at age 15 across all levels of genetic stock. Genetic stock also significantly increased average dominant height. While there was no significant difference between single family and bulk lot, dominant height increased by 2.1 feet and 2.2 feet, respectively, over unimproved stock. The interaction between competition control and genetic stock was not significant. Table 5 and Figure 3 summarize the least square means for average dominant height by treatment.

Table 4. Test of fixed effects for average dominant height (ft) for slash pine at age 15.

Source	Numerator Degrees of Freedom	Denominator Degrees of Freedom	Type III F	Pr > F
Genetics	2	32.7	4.55	0.0180
Competition Control	1	15.9	43.67	<.0001
Genetics* Competition Control	2	30.2	0.69	0.5093

Table 5. Summary of least squares means for average dominant height (ft) for slash pine at age 15.

	No Control	Complete Control	Average
Unimproved	41.6	45.9	43.8
Bulk Lot	44.4	47.6	46.0
Single Family	43.4	48.4	45.9
Average	43.1	47.3	45.2

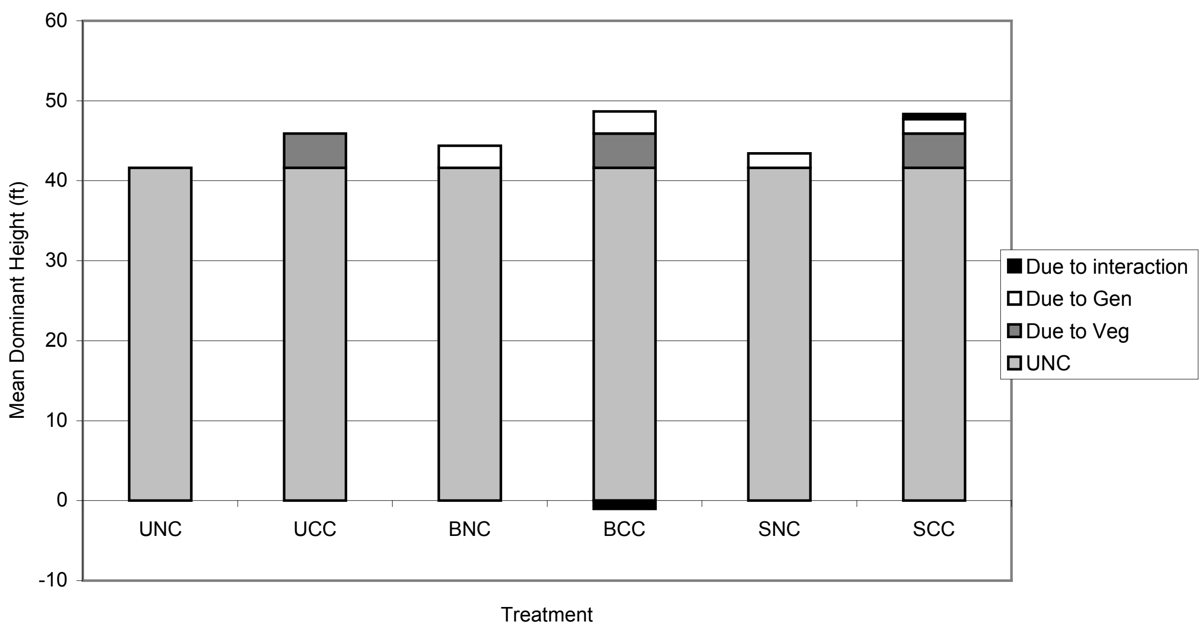

Figure 2. Effects of genetics and competition control on mean dominant height by treatment for 15-yr-old slash pine.

3.3 Basal Area per Acre

Vegetation control significantly affected basal area per acre for slash pine (Table 6). Competition control significantly increased basal area an average of 23.3 ft^2/ac across all levels of genetic stock. Genetic stock did not have a significant effect on basal area per acre. While there was no significant difference between single family and bulk lot, single family and bulk lot increased basal area by 3.3 ft^2/ac and 5.1 ft^2/ac. over unimproved stock. The interaction between competition control and genetic stock was not significant indicating the effects are additive in nature (Figure 3). Table 7 summarizes the least square means for basal area per acre.

Table 6. Test of fixed effects for basal area (ft^2/ac) for slash pine at age 15.

Source	Numerator Degrees of Freedom	Denominator Degrees of Freedom	Type III F	Pr > F
Genetics	2	58.4	1.21	0.3064
Competition Control	1	15.7	42.77	<.0001
Genetics* Competition Control	2	59.4	0.83	0.4409

Table 7. Summary of least squares means for basal area (ft^2/ac) for slash pine at age 15.

	No Control	Complete Control	Average
Unimproved	97.3	116.8	107.1
Bulk Lot	100.9	123.4	112.2
Single Family	96.5	124.2	110.4
Average	98.2	121.5	109.9

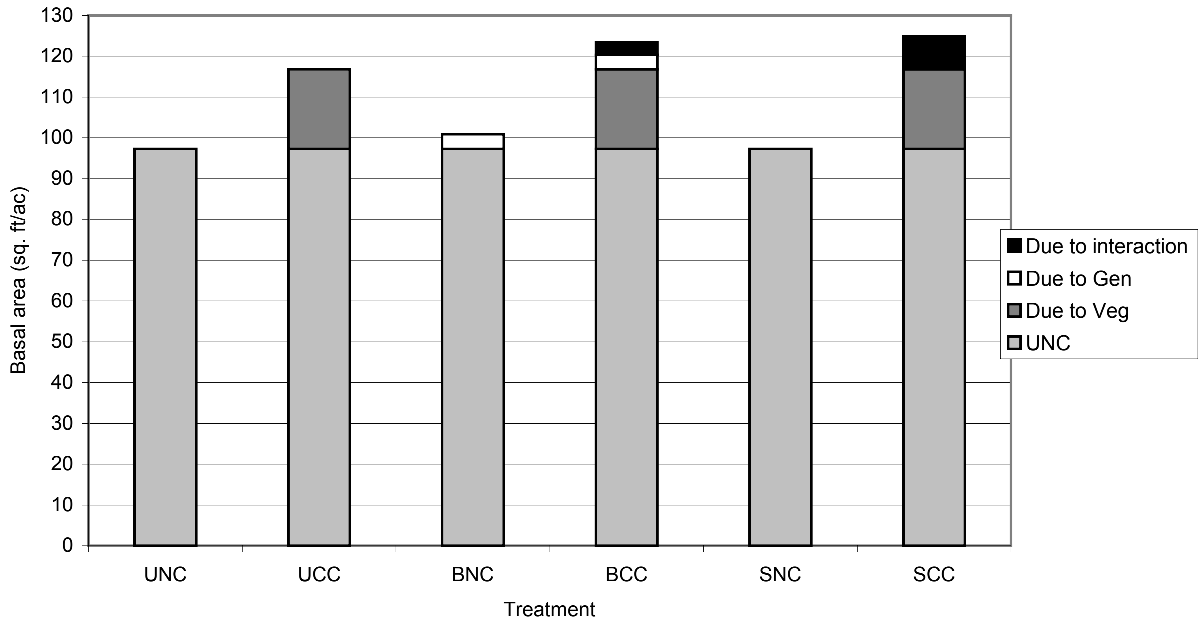

Figure 3. Effects of genetics and competition control on mean basal area per acre by treatment for 15-yr-old slash pine.

3.4 Total Volume per Acre

Table 8 gives the results of the tests of fixed effects for total outside bark volume per acre. Competition control significantly increased slash pine yield by an average of 669 ft^3/ac across all levels of genetic stock. Genetic stock also significantly increased total volume per acre. While there was no significant difference between single family and bulk lot, they increased yield by 206 ft^3/ac and 225 ft^3/ac, respectively, over unimproved stock. The interaction between competition control and genetic stock was not significant. Table 9 and Figure 4 summarize the least square means for total volume per acre by treatment.

Table 8. Test of fixed effects for total volume (ft^3/ac) for slash pine at age 15.

Source	Numerator Degrees of Freedom	Denominator Degrees of Freedom	Type III F	Pr > F
Genetics	2	60.1	3.64	0.0321
Competition Control	1	16	56.77	<.0001
Genetics* Competition Control	2	61.2	0.65	0.5281

Table 9. Summary of least squares means for total volume (ft^3/ac) for slash pine at age 15.

	No Control	Complete Control	Average
Unimproved	1999	2573	2286
Bulk Lot	2183	2839	2511
Single Family	2103	2881	2492
Average	2095	2764	2430

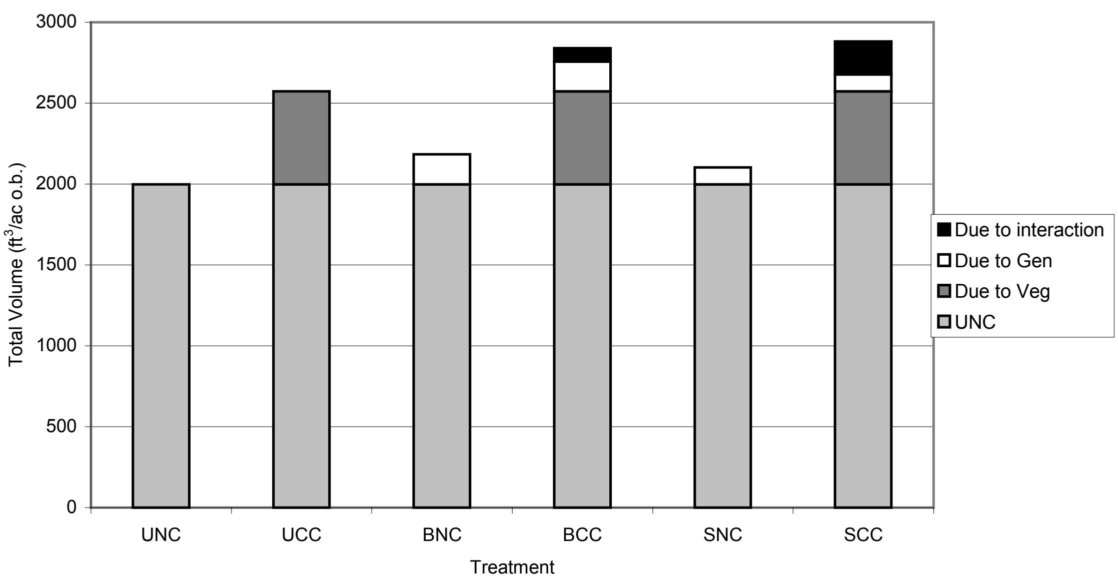

Figure 4. Effects of genetics and competition control on mean total volume per acre by treatment for 15-yr-old slash pine.

3.5 Merchantable Volume per Acre

Results for merchantable volume were essentially the same as for total volume. Competition control significantly increased merchantable volume (3-in. top) an average of 716 ft^3/ac. across all levels of genetic stock (Table 10). A t-test on the differences of least square means detected no significant differences between bulk lot and single family, but bulk lot increased merchantable yield 211 ft^3/ac and single family 205 ft^3/ac over unimproved stock. The interaction between genetic stock and competition control was not significant. Table 11 and Figure 5 summarize the least square means for merchantable volume by treatment.

Table 10. Test of fixed effects for merchantable volume o.b. to a 3-in. top o.b. (ft^3/ac) for slash pine at age 15.

Source	Numerator Degrees of Freedom	Denominator Degrees of Freedom	Type III F	Pr > F
Genetics	2	59.2	3.50	0.0367
Competition Control	1	15.9	61.27	<.0001
Genetics* Competition Control	2	60.5	0.54	0.5854

Table 11. Summary of least squares means for merchantable volume o.b. to a 3-in. top o.b. (ft^3/ac) for slash pine at age 15.

	No Control	Complete Control	Average
Unimproved	1744	2375	2059
Bulk Lot	1919	2622	2270
Single Family	1857	2671	2264
Average	1840	2556	2198

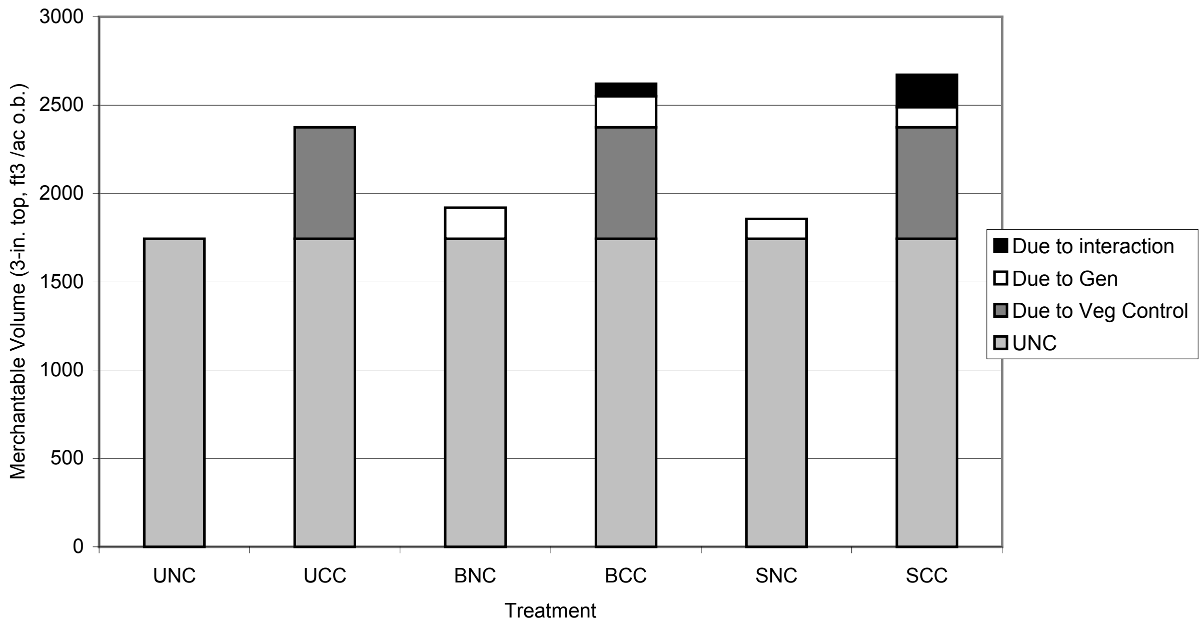

Figure 5. Effects of genetics and competition control on mean merchantable volume per acre by treatment for 15-yr-old slash pine.

3.6 Trees per Acre

There were no significant differences in trees per acre due to genetics or competition control for slash pine (Table 12). There was an average of 621 surviving trees per acre after 15 years for all slash pine installations (Figure 6).

Table 12. Test of fixed effects for trees per acre for slash pine at age 15.

Source	Numerator Degrees of Freedom	Denominator Degrees of Freedom	Type III F	Pr > F
Genetics	2	31.9	0.86	0.4326
Competition Control	1	16	0.43	0.5217
Genetics* Competition Control	2	30	2.08	0.1429

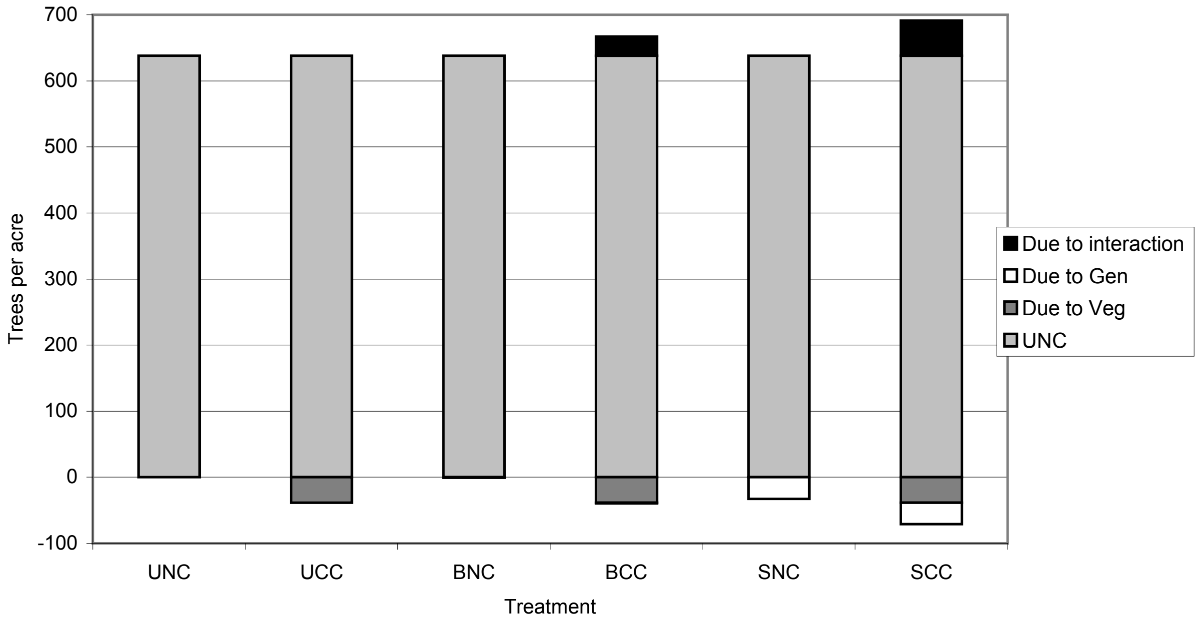

Figure 6. Effects of genetics and competition control on mean trees per acre by treatment for 15-yr-old slash pine.

3.7 Percent Fusiform Infection

Genetic improvement significantly contributed to reduced percent fusiform infections in the slash pine plots (Table 13). There were no significant differences between bulk lot and single family, but both reduced percent fusiform infections from 21.2% to 14.3% and 13.0%, respectively, over unimproved stock. Vegetation control significantly increased the rust infection level by 6.1% over the no vegetation control treatment (Table 14, Figure 7). The interaction between genetic stock and competition control was not significant.

Table 13. Test of fixed effects for percent fusiform infection for slash pine at age 15.

Source	Numerator Degrees of Freedom	Denominator Degrees of Freedom	Type III F	Pr > F
Genetics	2	31.1	7.32	0.0025
Competition Control	1	16.1	17.81	0.0006
Genetics* Competition Control	2	65.6	1.00	0.3746

Table 14. Summary of least squares means for percent fusiform infection for slash pine at age 15.

	No Control	Complete Control	Average
Unimproved	17.2%	25.3%	21.2%
Bulk Lot	11.4%	17.1%	14.3%
Single Family	10.8%	15.2%	13.0%
Average	13.1%	19.2%	16.2%

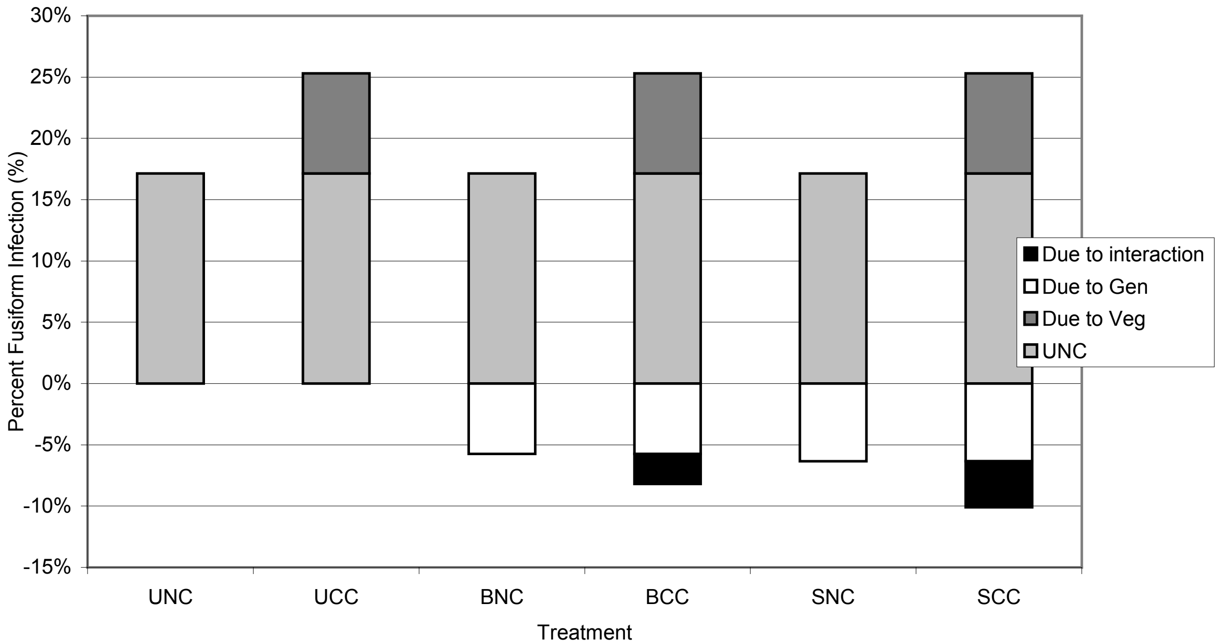

Figure 7. Effects of genetics and competition control on mean percent fusiform rust by treatment for 15-yr-old slash pine.

3.8 Percentage of Trees Defect Free

Table 15 gives the results of the test of fixed effects for average percent of trees defect free at age 15. Genetic improvement did not significantly affect the percentage of trees that were free from any major defects. Competition control significantly decreased the percentage of trees free from defect by 8% (Figure 9). Table 16 shows a summary of the least squares means by treatment. The interaction between genetic stock and competition control was not significant.

Table 15. Test of fixed effects for percentage of trees without major defects at age 15.

Source	Numerator Degrees of Freedom	Denominator Degrees of Freedom	Type III F	Pr > F
Genetics	2	31.5	1.51	0.2369
Competition Control	1	16.4	23.93	0.0002
Genetics* Competition Control	2	29.6	0.84	0.4418

Table 16. Summary of least squares means for percentage of trees without major defects at age 15.

	No Control	Complete Control	Average
Unimproved	22.2%	15.2%	18.7%
Bulk Lot	27.5%	17.2%	22.4%
Single Family	24.8%	17.9%	21.3%
Average	24.8%	16.8%	20.8%

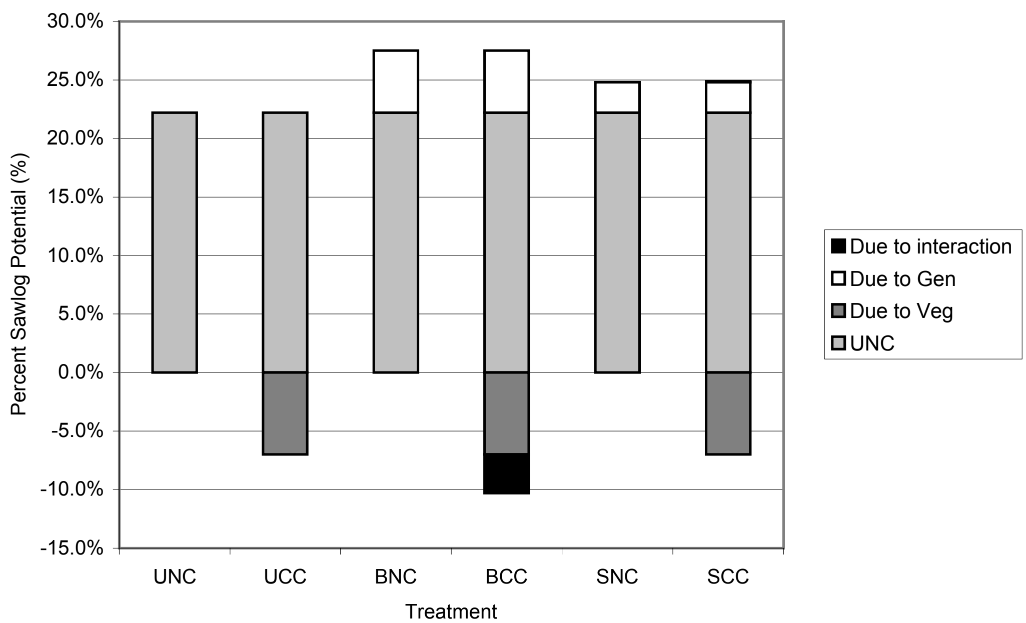

Figure 8. Effects of genetics and competition control on percentage of trees without major defects by treatment for 15-yr-old slash pine.

3.9 Percentage of Forked Trees

Competition control significantly affected the percentage of trees that were forked (Table 17 and Figure 9). Vegetation control increased forking by 2.5% versus no vegetation control. Table 18 shows a summary of least squares means for percentage of forked trees in the Coastal Plain. Improved genetics and the interaction between genetic stock and competition control were not significant.

Table 17. Test of fixed effects for percentage of forked trees for 15-yr-old slash pine.

Source	Numerator Degrees of Freedom	Denominator Degrees of Freedom	Type III F	Pr > F
Genetics	2	33.1	0.96	0.3939
Competition Control	1	15.8	27.94	<.0001
Genetics* Competition Control	2	34.8	0.56	0.5778

Table 18. Summary of least squares means for percentage of forked trees for 15-yr-old slash pine.

	No Control	Complete Control	Average
Unimproved	1.7%	4.2%	2.9%
Bulk Lot	1.7%	4.7%	3.2%
Single Family	1.4%	3.5%	2.4%
Average	1.6%	4.1%	2.8%

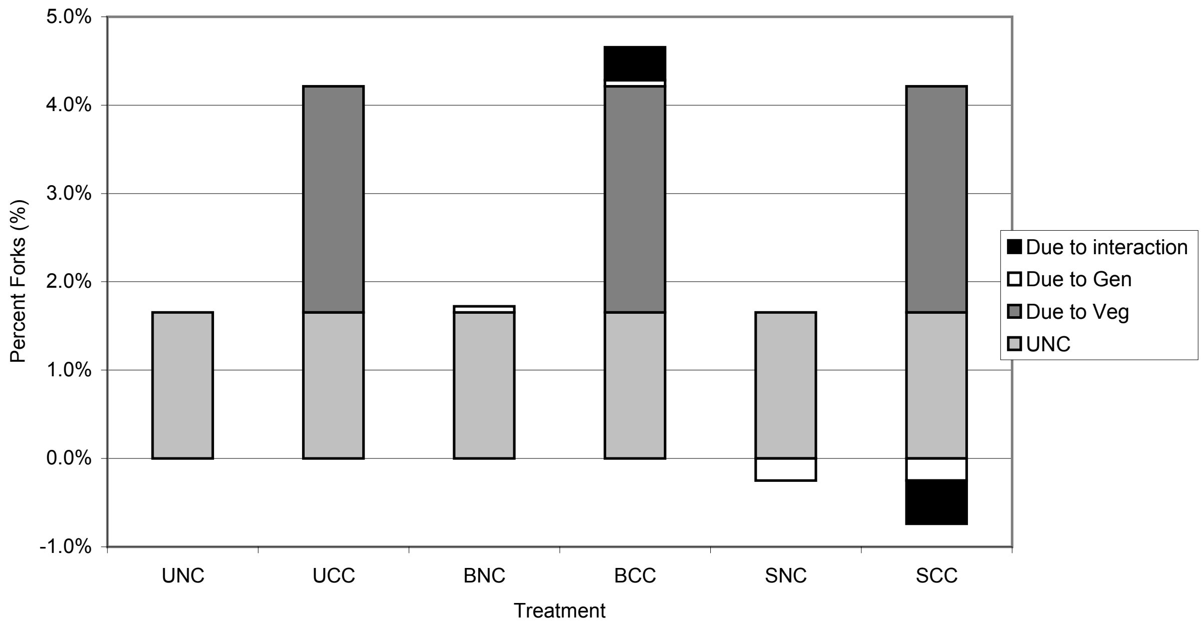

Figure 9. Effects of genetics and competition control on percentage of forked trees by treatment for 15-yr-old slash pine.

3.10 Percentage of Trees with Sweep

Competition control significantly affected the percentage of trees that had sweep at age 15 (Table 19). Vegetation control significantly increased sweep by 5.1% over no vegetation control (Figure 10 and Table 20). Improved genetics and the interaction between genetic stock and competition control were not significant.

Table 19. Test of fixed for percentage of trees with sweep for 15-yr-old slash pine.

Source	Numerator Degrees of Freedom	Denominator Degrees of Freedom	Type III F	Pr > F
Genetics	2	31.6	0.83	0.4442
Competition Control	1	16.4	6.56	0.0207
Genetics* Competition Control	2	30.3	0.33	0.7209

Table 20. Summary of least squares means for percentage of trees with sweep for 15-yr-old slash pine.

	No Control	Complete Control	Average
Unimproved	69.7%	74.5%	72.1%
Bulk Lot	65.9%	72.6%	69.2%
Single Family	69.7%	73.3%	71.5%
Average	68.4%	73.5%	71.0%

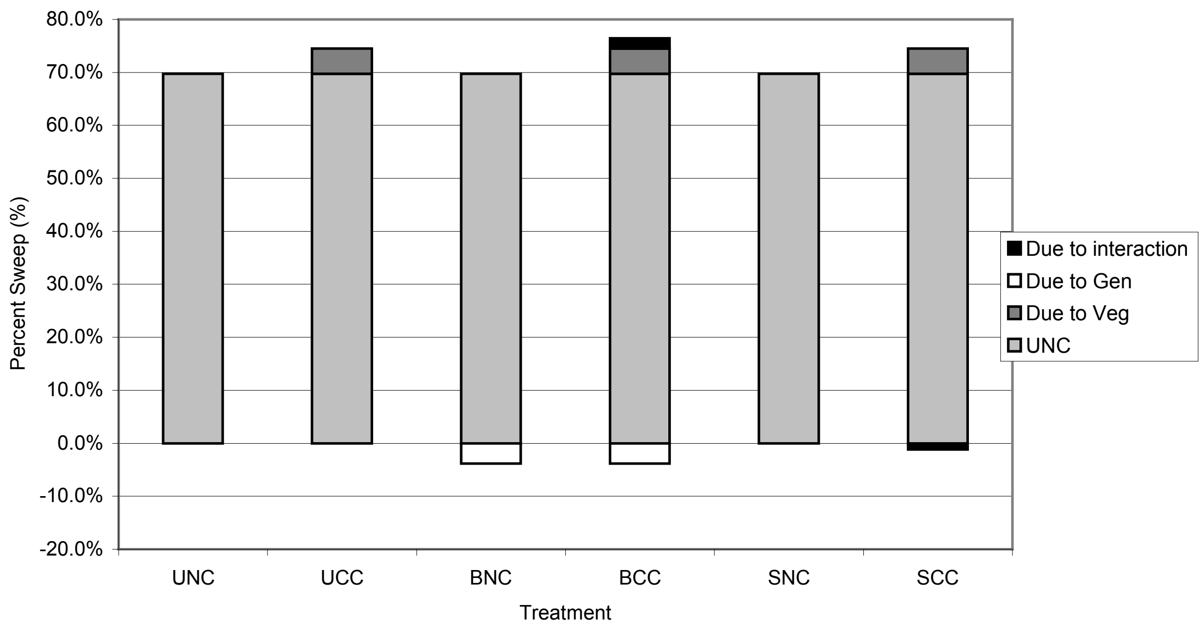

Figure 10. Effects of genetics and competition control on percentage of trees with sweep by treatment for 15-yr-old slash pine.

4 THREE-YEAR PERIODIC GROWTH

An analysis was conducted to examine the 3-year periodic growth, between ages 6 and 9, 9 and 12, and 12 and 15 of the dependent variables. The objective was to determine whether genetics and competition control are continuing to contribute to increased growth rates or whether the treatment combination means are converging over time. These trends are important for modeling purposes.

The 3-year periodic growth in mean dbh between ages 6 and 9, 9 and 12, and 12 and 15 are not significantly different for the competition control treatments (Table 21). These results indicate that the advantage in mean dbh for the competition control treatment is being maintained over time (Figure 11). Improved genetics significantly increased dbh growth between the ages of 12 and

15. Although bulk lot was not significantly different from unimproved stock, single family was growing significantly slower than unimproved stock (Figure 12). This indicates that mean dbh of the unimproved genetic stock is converging with the mean dbh of both bulk lot and single family improved genetic stock.

Table 21. Average difference (in.) in mean dbh growth for three 3-year periods. Different letters indicate a significant difference between complete vegetation control and no control.

3-year period	CC	NC
6 to 9	1.03 (a)	1.06 (a)
9 to 12	0.65 (a)	0.66 (a)
12 to 15	0.50 (a)	0.52 (a)

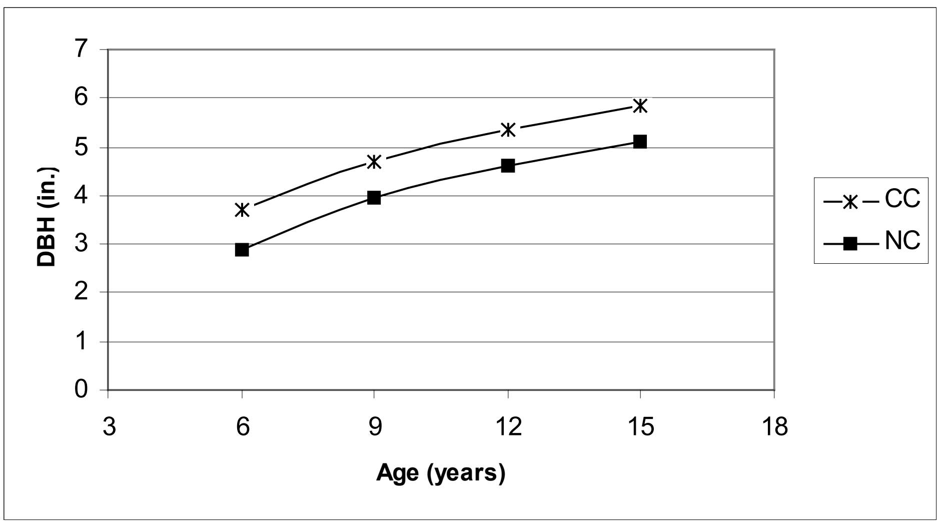

Figure 11. Mean dbh for the two competition control treatments for slash pine.

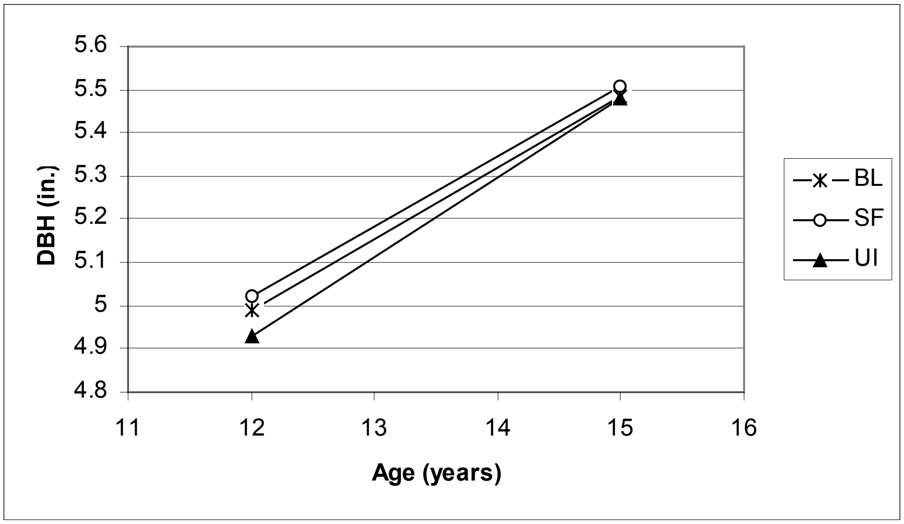

Figure 12. Mean dbh for unimproved, bulk lot and single family genetic stock slash pine.

In terms of mean dominant height growth between the ages of 12 and 15, the competition control * genetics interaction was significant at the alpha = 0.05 level. Table 22 shows the mean dominant height growth by treatment between the ages of 12 and 15. The bulk lot - no competition control treatment had the largest mean dominant height growth between the ages of 12 and 15 at 7.9 feet. It had significantly greater dominant height growth than the unimproved – no competition control treatment and the bulk lot – complete control treatment (Figure 13). No other treatment comparisons were significantly different.

Table 22. Average difference (ft) in mean dominant height growth by treatment between the ages of 12 and 15.

	No Control	Complete Control
Unimproved	6.9	7.6
Bulk Lot	7.9	7.1
Single Family	7.2	7.4

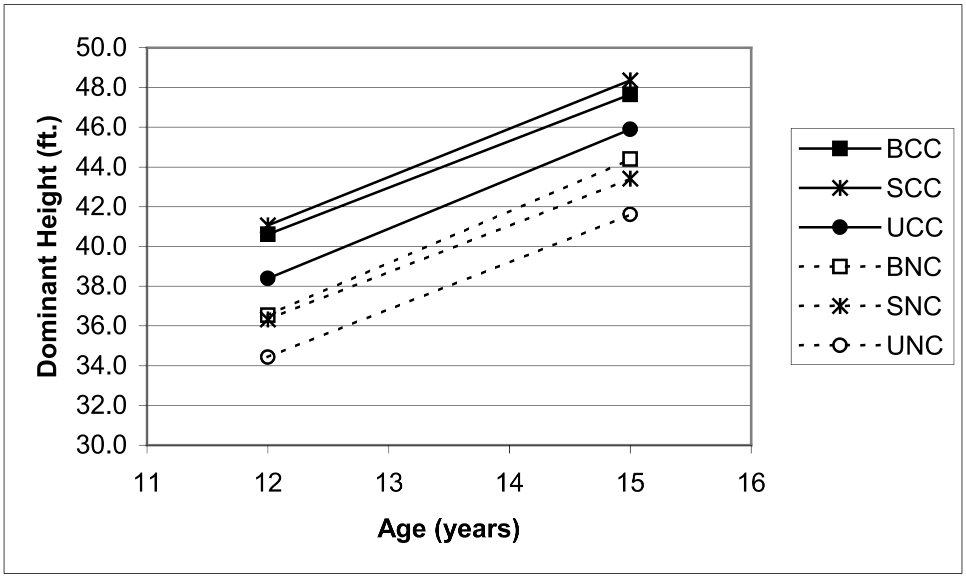

Figure 13. Mean dominant height by treatment for slash pine at ages 12 and 15.

There were significant differences between basal area per acre mean growth for the two competition control treatments during the period between 6 and 9 years. Complete competition control was still exceeding no control in growth. During the periods between 9 and 12 and 12 and 15 years there were no significant differences between competition control treatments (Table 23). These results indicate that the early gains in basal area per acre due to competition control are being maintained (Figure 14). The absolute gain in basal area per acre at age 15 averages approximately 23 ft^2/acre, indicating the large gains due to the complete control of competing vegetation. Genetics and the interaction between genetics and competition control did not significantly affect mean basal area per acre.

Table 23. Average difference (ft^2) in mean basal area growth for three 3-year periods. Different letters indicate a significant difference between complete vegetation control and no control.

3-yr period	CC	NC
6 to 9 yr	35.54 (a)	29.51 (b)
9 to 12 yr	21.85 (a)	19.85 (a)
12 to 15 yr	15.38 (a)	16.13 (a)

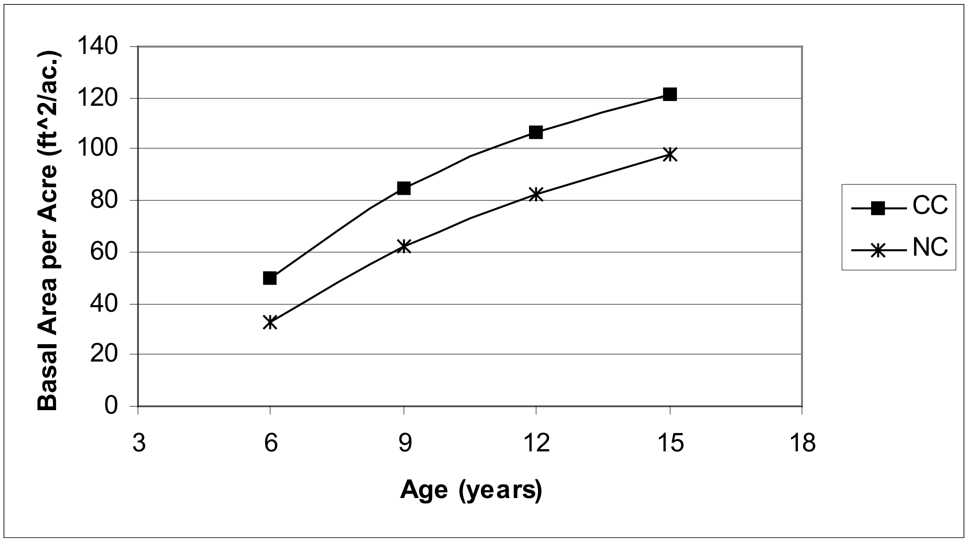

Figure 14. Mean basal area per acre for two competition control treatments for slash pine.

Genetics did not significantly affect mean total volume growth between the ages of 12 and 15. This is in contrast to earlier growth periods when improved genetics still significantly affected total volume growth (Table 24 and Figure 15). Competition control has significantly increased volume growth during all measurement periods, indicating that volume growth is still benefiting from competition control up to age 15 (Tables 25 and Figure 16). The interaction between genetic stock and competition control were not significant between the ages of 12 and 15.

Table 24. Average difference (ft^3/acre) in total volume for three 3-year periods. Different letters indicate a significant difference between genetic treatments.

3-yr period	UI	BL	SF
6 to 9 yr	638 (a)	687 (a,b)	696 (b)
9 to 12 yr	616 (a)	696 (b)	678 (b)
12 to 15 yr	629 (a)	660 (a)	629 (a)

Table 25. Average difference (ft^3/acre) in total volume growth for three 3-year periods. Different letters indicate a significant difference between complete vegetation control and no control treatments.

3-year period	CC	NC
6 to 9	789 (a)	558 (b)
9 to 12	737 (a)	589 (b)
12 to 15	676 (a)	608 (b)

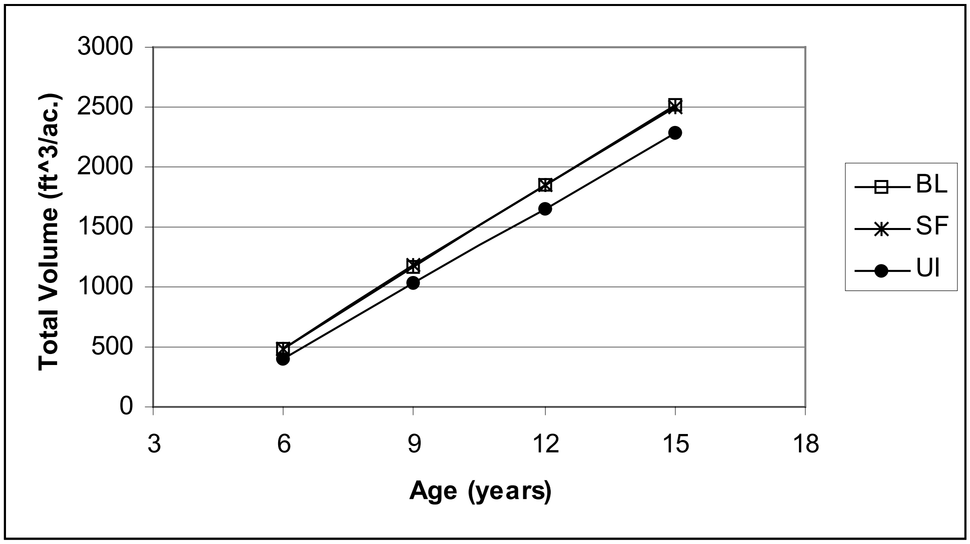

Figure 15. Total volume (ft^3/ac) for three genetic stocks for slash pine.

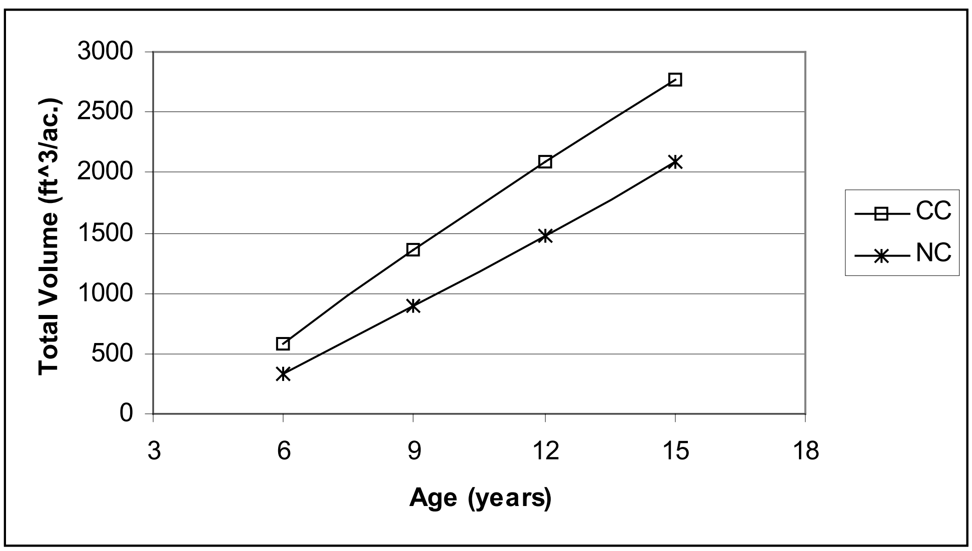

Figure 16. Total volume (ft^3/ac) for two competition control treatments for slash pine.

Improved genetics significantly reduced mean fusiform infections during the period from 6 to 9 yrs, and while not significantly different, the improved genetic stock also had a smaller increase in infection percentage during the periods from 9 to 12 years and 12 to 15 years.

5 CONCLUSIONS

Competition control significantly increased average tree characteristics and basal area per acre for slash pine. Improved genetics had no significant effect on average dbh or basal area per acre. Average dominant height, total and merchantable volume were significantly increased by both improved genetics and competition control, and the effects are additive in nature. Neither competition control nor genetics significantly affected trees per acre. Improved genetics significantly reduced the percent fusiform infection while competition control significantly increased the infection rate.

The results of the 3-year periodic growth analysis between the ages of 12 and 15 showed that there were no significant differences in dbh growth due to the competition control treatments. This indicates that the early gains due to competition control are being maintained through age 15 for slash pines. Improved genetics significantly affected dbh growth between ages 12 and 15. There was no significant difference between bulk lot and unimproved, but single family was growing significantly slower than unimproved genetic stock. In terms of mean dominant height, there was a significant interaction between improved genetic stock and competition control between the ages of 12 and 15. Basal area per acre growth was not significantly affected by either improved genetics or competition control during the 12 to 15 year growth period. For total volume per acre, competition control continues to significantly increase growth.

The results of this study show that there is a clear benefit from using intensive competition control and improved genetics. Complete competition control has increased total volume by almost 700 ft^3/acre over no competition control. Improved genetic stock has increased total volume an average of 10%. These volume percentage gains fall in the range estimated by progeny tests reported by Talbert et al. (1985). For the age 15 analyses, the gains in total and merchantable volume due to genetics and competition control were determined to be additive in nature which indicates managers can expect to receive the full benefit of both improved genetics and competition control if they use both treatments.

6 LITERATURE CITED

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